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ABSTRACT

This newsletter reports on the status of biology education in the United States. It states that biology has entered its "golden age" because of the emergence of biotechnology, ecology, agricultural productivity, and human biology as major societal issues. This report discusses the status of the informal national curriculum of biology, involving textbooks and standardized tests, and identifies six major efforts underway in the United States; these have to do with curricula, programs, and concepts. This paper also reports on a poll of award winning biology teachers that revealed some common characteristics. It indicates that successful biology teachers stress process and thinking skills. It states that these teachers generally enjoy their work and spend a great deal of out-of-school time preparing for classes. Many teachers attempt to keep up to date by attending meetings and conventions and most view their work as critically important to developing responsible students. The descriptions of eight exemplary secondary biology programs are included. A brief list of additional resources is provided. (CW)

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Current Trends in Biology Education

Biology education is not simply learning to identify plants and dissecting frogs. Today, it means providing young people with the knowledge to make intelligent decisions about themselves and their environment.

Biology has entered what some people feel is its "golden age." Indeed, biology and biotechnology have emerged as keys to the nation's future. Because solutions to many of the world's problems depend on biology, improving biological education has become a national priority.

For example, environmental issues such as pollution and population growth are biological issues, as is the destruction of tropical ecosystems and its effects on global climate and survival of the world's species. The science of ecology is entering a stage of development in which it is increasingly possible to predict the effects of our activities on communities of organisms. Further ecological research and an ecologically educated citizenry are essential if society is to solve the kinds of problems mentioned above.

Agricultural productivity and providing food for more than five billion people are also biological issues. Population growth, erosion, pests, and diseases all create pressure for increased productivity. New crops must be developed and present plant and animal varieties improved.

The emergence of AIDS also emphasizes the need for continuing research on human biology and medicine. Aging and degenerative diseases must also be studied as the nation's population ages. Only increased research in basic biology will enable us to discover simple solutions to medical problems.

Given the importance of biological knowledge, we must improve biology education so that we can build a biologically literate society and provide people with the background for biology-based careers and the knowledge to make intelligent decisions about biology-related issues.

In the Classroom

Depending on perspective and definition, there may or may not be a national curriculum of biology. There is a considerable uniformity of content in biology texts and courses; standardized biology tests like the SAT, CLEP, and AP tests have well-defined content, as does the new National Biology Test being prepared by the National Association of Biology Teachers and the National Science Teachers Association. Secondary biology curricula are often designed to help students do well on these tests, and thus content is standardized.

Biology textbooks resemble one another in many respects. The slim profit margins in the national textbook publishing market make publishers reluctant to gamble on textbooks that are substantially different from the norm, and this also leads toward uniformity.

However, there is no formal national curriculum, and there is considerable diversity in the way biology is taught. Diversity is especially evident when comparing the time devoted to laboratory activities, the emphasis on selected topics (many "biology" courses are, in effect, vertebrate zoology courses), and the time spent by teachers in keeping abreast of advances in biology.

Thus, biology teachers can generally agree on an outline of content for a biology text or course, but exhibit considerable variation regarding what and how they actually teach.

Biology teaching is not static, and a number of innovative curricula, programs, and concepts can be identified.

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• *The Biological Sciences Curriculum Study* is an ongoing attempt to incorporate the best teaching methodologies into biology curricula. The emphasis is on students as participants in the learning process rather than as recipients of knowledge, and to this end the BSCS curricula have always been oriented toward laboratory and field activities.

• *The Advanced Placement Biology* program is aimed at providing high school students with the equivalent of a college biology course, thus giving them advanced standing in college. An outline of content defines the course. Six laboratory exercises have recently been added to the AP biology curriculum, with six more planned for the 1987-88 school year. The AP test will be revised to include questions about the laboratory exercises.

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• *Science-Technology-Society* issues are abundant in biology, and biology teachers are putting increased emphasis on teaching about nuclear winter, genetic engineering, and other bioethics topics.

• *Curriculum supplements* can be added to traditional curricula instead of revising them. Three examples are the CLASS project, an inquiry-oriented set of materials that teaches students to identify and solve environmental problems; Project WILD, an interdisciplinary set of materials emphasizing wildlife while introducing environmental and conservation issues; and Project Learning Tree, a set of environmentally-oriented activities that stress understanding of ecological relationships.

• *The National Biology Test* is being prepared by the National Association of Biology Teachers and the National Science Teachers Association. This national exam is intended to provide teachers with a means of evaluating the progress of students in comparison with other students nationwide. The test is not intended to be a tool for evaluating the performance of teachers.

• *National Certification* for science teachers is being pursued by the National Science Teachers Association. Its criteria are rigorous and should serve as a goal for professional science educators.

A Look at the Teachers

A poll of biology teachers, most of whom were recipients of the National Association of Biology Teachers Outstanding Biology Teacher Award or the Presidential Award for Excellence in Science and Mathematics Teaching, revealed some common characteristics of successful biology teachers and teaching methods.

Most teachers teach biology as a process and stress thinking skills. In the words of one teacher, the idea is to "make science a verb, not a noun." To this end, they incorporate a high percentage of "hands-on" activities in their teaching. They generally enjoy biology and their students, and are enthusiastic about their work to the point that they regularly spend a great deal of out-of-school time preparing for their classes.

Most teachers are able to choose their own textbooks and supplement them with a variety of resources including professional and popular journals, people and materials from other institutions, and materials they prepare themselves. Many attend national or regional meetings such as the National Convention of the National Association of Biology Teachers, are conscious of the rapidly changing nature of biology, and attempt to keep up-to-date.

Finally, most understand that their work is critically important, since an understanding of biology is essential to students becoming informed voters/citizens.

The teachers polled were not alike in all respects. They had different interests within biology, and thus their courses had different emphases. Their teaching styles varied with their personalities. And there was considerable variation in the amount of time, space, and money available to them.

While the teachers surveyed enjoyed their work, a number of problems involving time, space, money, and people frustrated many of them. Time was a problem, especially time for laboratory activities and their preparation. Some complained of nagging and frequent interruptions for non-academic activities. Insufficient space for preparation, storage, display, and class/laboratory activities bothered some, as did insufficient funds.

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A few teachers were annoyed by student apathy, and others were frustrated when administrators failed to recognize the importance of laboratory activities and the effort required for good laboratory teaching.

Looking Ahead

Many problems, such as food production, have biological sources, and most have biological consequences. For too long we have delegated the responsibility for solving these problems to "blue ribbon panels." Indeed, there is certainly no shortage of "expert" advisory boards and consultants that appear almost daily before various government committees.

However, our problems have not only persisted, but have intensified. Never before has our environment been stressed as it is today. Clearly, a few "experts" and "blue ribbon panels" will not solve these biological problems. If it were that simple, problems such as species extinction and overpopulation would have disappeared long ago.

Rather, these problems will be solved only by a biologically literate society. It is the responsibility of biology teachers to create this biological literacy. We must teach the process of biology, the concepts of biology, the excitement of biology, and the importance of biology to everyday living. Such a "trend" in biological education would not only improve our standard of living, but would also contribute to the stewardship of our fragile planet.

Exempli Gratia

POINT LOMA HIGH SCHOOL, 2335 Chatsworth Blvd., San Diego, Calif. 92106. *Contact:* Penny Wilson, science department.

A comprehensive biology program at Point Loma High School offers a wide variety of academic studies to satisfy an assortment of ability and interest levels. Among the course offerings are Biology 1-2 and Zoology 1-2.

Biology 1-2 is a comprehensive lab course that covers five major areas: cell biology, evolution and adaptations, botany, comparative invertebrate and vertebrate anatomy, and ecology (emphasizing endangered species).

Studies in cell biology and current developments in genetic diseases develop the students' microbiology lab techniques and observation skills through the development of a series of formal plate drawings. The theory of evolution and natural selection and the concept of adaptation are studied through activities that develop reading, writing, and critical thinking skills.

Studies in invertebrate and vertebrate zoology focus the students' awareness on adaptations as well as evolutionary relationships. Dissection is also a key part of the botany unit as students study roots, leaves, seeds, and flowers, and produce scientific plate drawings of each plant structure.

Environmental awareness and the recognition and protection of endangered species is a major emphasis at the conclusion of the course, as these topics bring together all the previous topics, critical thinking skills, and values training developed throughout the school year.

Zoology 1-2 is offered to students who plan a career in animal behavior, marine biology, or veterinary medicine. During the first semester, this lab course stresses comparative invertebrate and vertebrate anatomy through frequent dissections and lab studies of assorted necropsied wild species.

Studies in animal evolution and adaptations involve students in the construction of imaginary birds and model zoo enclosures suited to polar bear adaptations.

Second semester coursework emphasizes the development of a heightened awareness of the environmental, ecological, and wildlife topics through lab activities from the PROJECT WILD curriculum guide. In addition, endangered species, captive breeding, and genetics are studied as students participate in hands-on activities utilizing a variety of specimens confiscated by U.S. Customs agents at U.S. border checkpoints.

MENLO-ATHERTON HIGH SCHOOL, 555 Middlefield Rd., Atherton, Calif. 94025-3483. *Contact:* Stan Ogren, biology teacher and department chairman.

The *Biology* course is based on criterion-referenced performance objectives. It is a course designed to meet the needs of all students of average ability regardless of career aspirations. Emphasis is placed on laboratory experiences requiring critical thinking and problem-solving skills. The text is the fourth edition of *BSCS (BLUE) Biological Science–A Molecular Approach.*

Advanced Placement Biology is a college-level course designed for secondary school juniors and seniors. An extension of the regular biology course, it provides students with an opportunity to study selected topics in greater depth and allows for the introduction of new ideas.

Most of the curriculum in the Advanced Placement Course Description Booklet is included. The primary texts are *Biosphere–The Realm of Life* by Wallace, King, and Sanders, and *Principles of Anatomy and Physiology* by Tortora and Anagnostakos. The primary laboratory manual is *Vertebrates, A Laboratory Text* by Wessells and Center.

Laboratory activities including the six AP Lab Investigations are an integral part of the course, with emphasis placed on experimentation, dissection, and studies with the microscope. Collateral and reference reading is expected. The course usually meets five periods per week in a self-contained laboratory classroom.

The two sections are scheduled on either side of the lunch period. This provides the students with the option of using the lunch hour if an activity such as an examination or laboratory investigation requires additional time. Good use is made of former and current Advanced Placement Biology students as aides in both Biology and Advanced Placement Biology.

COLCHESTER HIGH SCHOOL, Box 31, Laker Lane, Colchester, Vt. 05446. *Contact:* Betty Carvellas, science department chair.

All students graduating from Colchester High School must complete two years of science, one of which must be biology. Students in their sophomore year may choose from three levels of life science or two levels of biology. Students wishing to go beyond introductory biology may choose anatomy and physiology or advanced biology.

Thus, biology teachers can generally agree on an outline of content for a biology text or course, but exhibit considerable variation regarding what and how they actually teach.

In addition, four interdisciplinary courses offer a unique way to learn.

- Andros Adventure, a biology/art program that is offered every other year, culminates in an eight-day field study on Andros Island in the Bahamas.
- Scientific Illustration is offered on non-lab days to provide students with an alternative to study hall.
- Science and Society stresses the importance of making informed decisions in a rapidly changing technological society. Students in the class research controversial STS issues, write position papers, and take action on their stated positions.
- Human Impact on the Lake Champlain Basin is an interdisciplinary program that utilizes computers, telecommunications, and traditional research methods to examine the effects people have had on the Lake Champlain region. The course exhibits close collaboration between the University of Vermont and C.H.S for curriculum development, guest speakers, data sharing, and program evaluation.

A new course, Science Topics, is being taught for the first time in 1987-88. Each quarter is taught by a different teacher. The course, designed for low-ability students, is oriented to the students' everyday experience.

All core courses with the exception of Life Science offer extra lab periods in order to provide an opportunity for students to develop the inquiry and reasoning skills so important in science education.

SOUTH JUNIOR HIGH SCHOOL, 500 East Parkway St., Morgantown, W.Va. 26505. *Contact:* Edward C. Keller III.

West Virginia has set forth basic learner outcomes in all academic areas. The life science courses at South Junior High are designed to exceed these learner outcomes in both content and process.

Emphasis in life science is placed on hands-on experiences designed to meet students' individual ability levels. This is accomplished through the use of formal labs, inquiries, research papers, and creative problem-solving exercises. The purpose is to excite student interest and reinforce the use of scientific method and experimental design in a problem-solving setting.

Our academically able students are scheduled into a program that enables them to move at a faster pace through the basic concepts. This provides time for more in-depth investigations and additional high interest enrichment activities.

GRAND RAPIDS SENIOR HIGH SCHOOL, Conifer Dr., Grand Rapids, Minn. 55744. *Contact:* Ronald Salladay, 10th grade biology teacher.

Assertive discipline allows students to make behavioral choices and to accept consequences for their own choices. It also enables Salladay to keep control over a year-long course that spends 7 out of 10 days on laboratory or hands-on activities.

All assigned reading is done outside class and there are no "busy work" worksheets. Lectures or discussions are given to introduce new material or summarize lab activities.

Student role-playing activities demonstrate biological concepts such as active and passive transport, the human immune system, the AIDS virus, and protein synthesis.

Only increased research in basic biology will enable us to discover simple solutions to medical problems.

Each semester, students are required to make a model of some organ or organism such as bacteria, protists, or neurons. Students also keep daily "Neuron Notes," which are one-sentence statements describing what they *learned* that day, not what they *did*.

Finally, once a year they are required to do an "I Search Paper," which is similar to a research paper, but is written in story form.

PRESQUE ISLE HIGH SCHOOL, 16 Fort St., Presque Isle, Maine 04769. *Contact:* Richard Lord, Jr., biology teacher.

For the college preparatory biology classes, Lord has developed a series of learning packets. The program consists of a core curriculum of basic activities done by all students and a set of student-choice activities in each packet from which each pupil selects a prescribed number to complete. Activities are largely hands-on and include a variety of types, from laboratory investigations to simulation games. Lord de-emphasizes lecturing and encourages students to develop skills to find information for themselves. The course culminates in a study of ecology in which the chief activity is a three-day, 500-mile trip to the ocean to study the intertidal ecosystem.

Biology II, during the fall semester, focuses on communication skills in biology. Students increase their scientific vocabulary by learning word roots and how they are put together to form words. Each student then brings in a guest speaker on a biological subject and writes an article based on this talk.

Finally, each student writes a research paper on an approved topic and presents an oral seminar on the research. The articles and research papers are printed in a journal which the class publishes.

The spring semester of the course deals with microbiology and includes extensive laboratory work with each student ultimately responsible for correctly identifying an unknown bacterial species using cultural, morphological, and biochemical characteristics.

Human Biology, another upper-level course, focuses on the human species. Starting from a historical anthropological perspective, students study the human's place in the biosphere, human behavior, anatomy and physiology, and genetics. Laboratory and hands-on activities are used whenever possible and a full-day field trip to the local medical center is included as a follow-up to the anatomy and physiology study. The visit includes demonstrations of many medical procedures such as laboratory tests, respiratory testing, and EEG recording.

PROSPECT HIGH SCHOOL, 801 West Kensington Rd., Mount Prospect, Ill. 60056. *Contact:* Jim Bertoglio.

In Biology Exploration, basic concepts of biology are investigated through laboratory and classroom activities that have particular relevance to the living world. Emphasis is placed on the human body, its functioning, and its relationship to a healthy environment.

To meet the needs of low-achieving science students who have deficient reading skills, this course provides high interest content at a slow place. A laboratory approach to learning and understanding biological concepts is utilized. Placement in this course is made on the basis of test scores, counselor recommendation, and teacher appraisal of past performance.

Among the skills taught in this course are scientific method applied to problem solving, measurement, and development of observation skills. The major units of study are cell structure and function, human biology, animal anatomy and physiology, health, reproduction, genetics and heredity, microbiology and disease, comparative study of plant anatomy and physiology, ecology, and biological change with time.

Generally, class size is kept small to provide as much individual attention as possible. Students are often given extra help by reading teachers. Every effort is made to

provide students with a positive experience and success.

Attempts are made to relate the science of biology to the everyday life of the students. Successful completion of this course meets the graduation requirement for Biological Science.

We must teach the process of biology, the concepts of biology, the excitement of biology, and the importance of biology to everyday living.

Biology is a general survey course of living things: animals, plants, and microorganisms. It is designed to be taken during the freshman year and meets one year of a two-year graduation requirement for laboratory science.

Topics covered in general Biology include scientific methods and tools, cellular structure and function, biochemistry, genetics, human anatomy and physiology, animal classification (with some dissection), plant structure and function, evolution, and environmental studies. Educational films, field trip(s), laboratory experiences, reading, and classroom discussion are methods used in presenting the course content.

After successfully completing Biology, students are required to complete one year of study in physical science prior to graduation.

The content of the Biology Honors course is identical to general Biology with increased emphasis on laboratory work and research.

Students are presented a rigorous general survey of living things: plants, animals, and microorganisms. It is designed to be taken during the freshman year and meets one year of a two-year graduation requirement for laboratory science.

The Honors level course is designed to be taken by students who have shown proficiency in science. Placement in this course is based upon recommendation of junior high school science teachers and test scores.

The content of this course includes topics pertaining to scientific method, chemistry, cell biology, energy use, reproduction, genetics, origins of life, anatomy and physiology, taxonomy, and environmental studies. Materials for this course are presented through a variety of techniques such as laboratory experiments, discussion, readings, and educational films.

This course is generally considered to lead to further science experience, beyond the sophomore Physical Science requirements, at the high school level. Successful completion of this course meets the District 214 requirement for graduation. Many students who successfully complete this course elect to enroll in Chemistry as sophomores.

ALLEN HIGH SCHOOL, P.O. Box 1017, 601 East Main St., Allen, Tex. 75002. *Contact:* Alton L. Biggs, science chairman.

Allen High School offers its students a contemporary biology program consisting of five course choices. These courses are structured to enhance understanding of the biological sciences for all ability and interest levels.

Introduction to Biology is a basic exit-level course that focuses on biology in daily living and is designed for students with deficiencies in reading and math comprehension.

Biology I introduces and develops the major concepts of biology. Environmental Science and Human Physiology and Anatomy are elective offerings for students with particular interests in one of these areas.

Biology II—Advanced Placement/Honors is a senior level course designed to challenge the academically oriented student by focusing on an in-depth study of some of the more difficult concepts of biology.

All biological science courses utilize the hands-on approach in laboratory settings. Excluding lecture, pre-lab, and post-lab exercises, at least 40 percent of class time is spent in the laboratory.

Each biology laboratory is equipped with a closed-circuit color videocamera for showing students microscopic objects on a television screen. The teacher is able to point out particular structures or microscopic organisms to the entire class in this manner. Students then use their own microscopes for first-hand observation.

Live material makes laboratory exercises more exciting, and is used whenever possible. Plants are maintained in a shared atrium. Animals from insects to gerbils are studied using non-invasive techniques. The school surroundings are also used when studying concepts concerning the environment.

Allen High School maintains an extensive collection of prepared microscope slides, classroom models, filmstrips, 16mm films, and books. These and other teacher-made materials contribute to make the program a challenging one for all students.

Science courses are viewed as drifting toward obsolescence, out of touch with individual needs, with social practices, and the cultures of modern science and technology," Paul DeHart Hurd wrote in the September 1985 *NASSP Bulletin*.

Hurd, professor emeritus of education at Stanford University, provided a synthesis of the recommendations for the reform of secondary school science education:

- An overall purpose of secondary school education in the sciences is to develop scientifically, technologically, and culturally literate students for active participation in a science/technology-oriented democracy.
- The science curriculum should be a balance of science and technological concepts and modes of thinking presented as an integrative system and in the context of personal and social themes.
- The subject matter for science courses should be selected with regard to the nation's social system—its shared goals, values, and common life experiences—and for its practical usefulness in human affairs.
- The teaching of science should foster an awareness of one's personal obligations to the human community and the well-being of the nation, and provide an understanding of oneself.
- The skills to be developed in science teaching are those essential for acquiring, processing, and utilizing information in the contexts of thinking critically, making decisions, and forming ethical judgments. These are also the skills needed for sustaining independent and lifelong learning.

Additional Resources

Publications:

The American Biology Teacher.
Contains information about biology and biology teaching, especially at the secondary level. Published monthly during the school year by the National Association of Biology Teachers, 11250 Roger Bacon Dr. #19, Reston, Va. 22090. The following states have organizations affiliated with NABT: Colorado, Illinois, Kansas, Maryland, Michigan, New Jersey, New York, South Carolina, and Texas.

The Science Teacher.
Contains articles about teaching all sciences at the secondary level. Published monthly during the school year by the National Science Teachers Association, 1742 Connecticut Ave., NW, Washington, D.C.

Biology Digest.
Contains abstracts of articles published in biology journals. An appropriate resource for both teachers and secondary students. Published monthly during the school year by Biology Digest, 143 Old Marlton Pike, Medford, N.J. 08055.

Science and Creationism: A View from the National Academy of Sciences.
A concise statement of the scientific point of view on this controversial topic. Published by National Academy Press, 2101 Constitution Ave., NW, Washington, D.C. 20418.

Addresses for Curricula:

Advanced Placement Biology
The College Board, Educational Testing Service, Princeton, N.J. 08541.

Biological Sciences Curriculum Study
The Colorado College, Colorado Springs, Colo. 80903.

The Class Project
Jack Greene, Educational Material Development, National Wildlife Federation, 1412 Sixteenth St., NW, Washington, D.C. 20036.

Project Learning Tree
Kathy McGlauflin, American Forest Institute, 1619 Massachusetts Ave., NW, Washington D.C. 20036.

Project Wild
Cheryl Charles, Salina Star Route, Boulder, Colo. 80302.

Kudos

This *Curriculum Report* was developed by Daniel E. Wivagg and Randy Moore, Department of Biology, Baylor University, Waco, Tex.

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